Analyzing NOAA Storm Damage Data

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Project Description

- NOAA Provides data on storms that have caused injuries or significant property damage dating back to 1950. The data set describes the location of event, type of weather, and magnitude of damage. There are approximately 1.8 MM weather events recorded.
- Prior Work:
  - “Student Research Abstract: Unsupervised Key Term Extraction of Tornado Narratives from NOAA Storm Events Database” –Emma Louise McDaniel
    - Narratives were text mined in order to retrieve the impacts of the disasters in order to structure the data for further use
  - “Some Comments on the Reliability of NOAA's Storm Events Database” –Renato P Dos Santos
    - Supported by limited statistical analysis, came to the conclusion that the database suffers from incompleteness and inconsistencies
- Datasets:
  - https://www.ncei.noaa.gov/pub/data/swdi/stormevents/csvfiles/

Questions

- Have weather events become more dangerous to people?
- Is the magnitude of property damage indicative of higher risk of injury to people?
- Has the damage caused by severe weather events increased over time?
- Have severe weather events increased over time?
- Are some areas more prone to severe weather effects?

Data Preparation

- Data Cleaning & Preprocessing
  - Data broken up into yearly reports which were combined in Pandas dataframe
  - Simplified, combined and made data types consistent between files

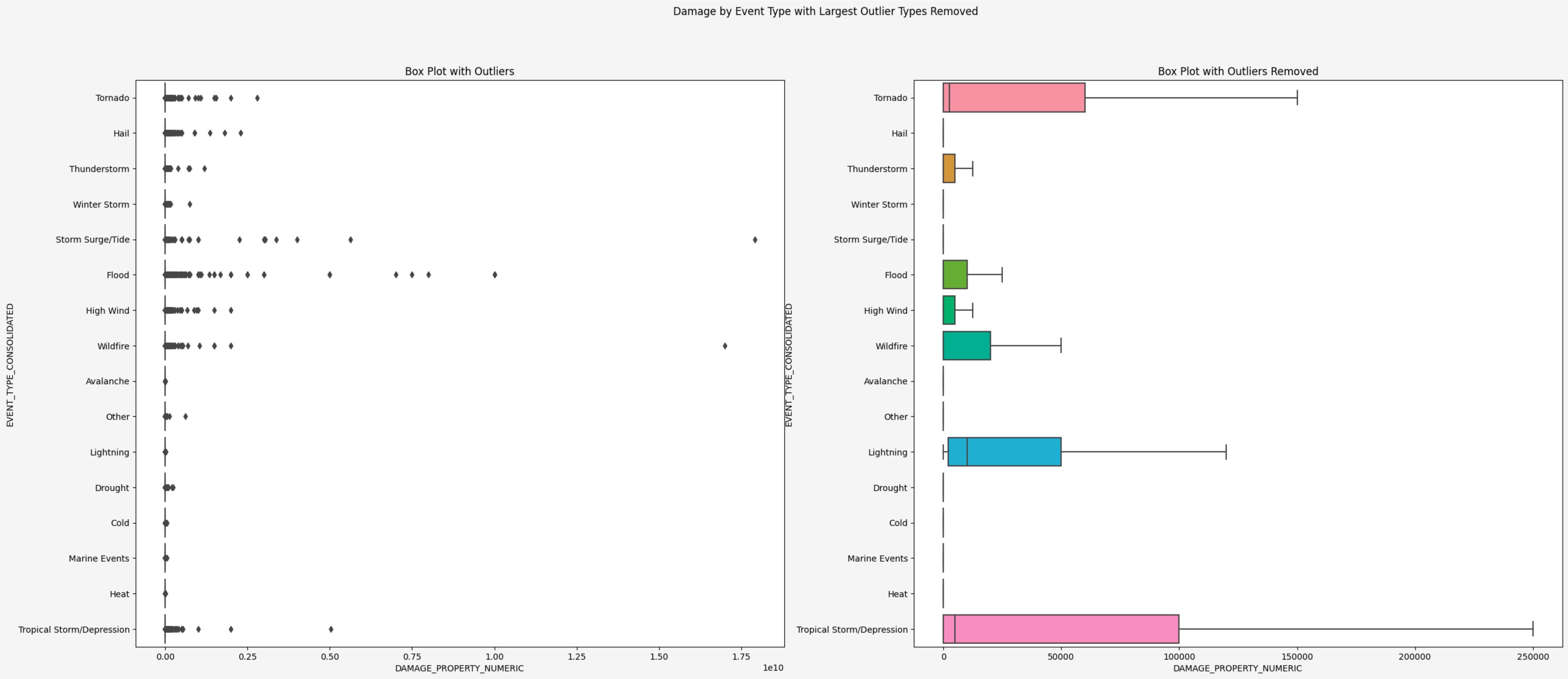
- Data Integration
  - Codes for county and regional data were re-labeled for readability and consistency
  - Census data per county

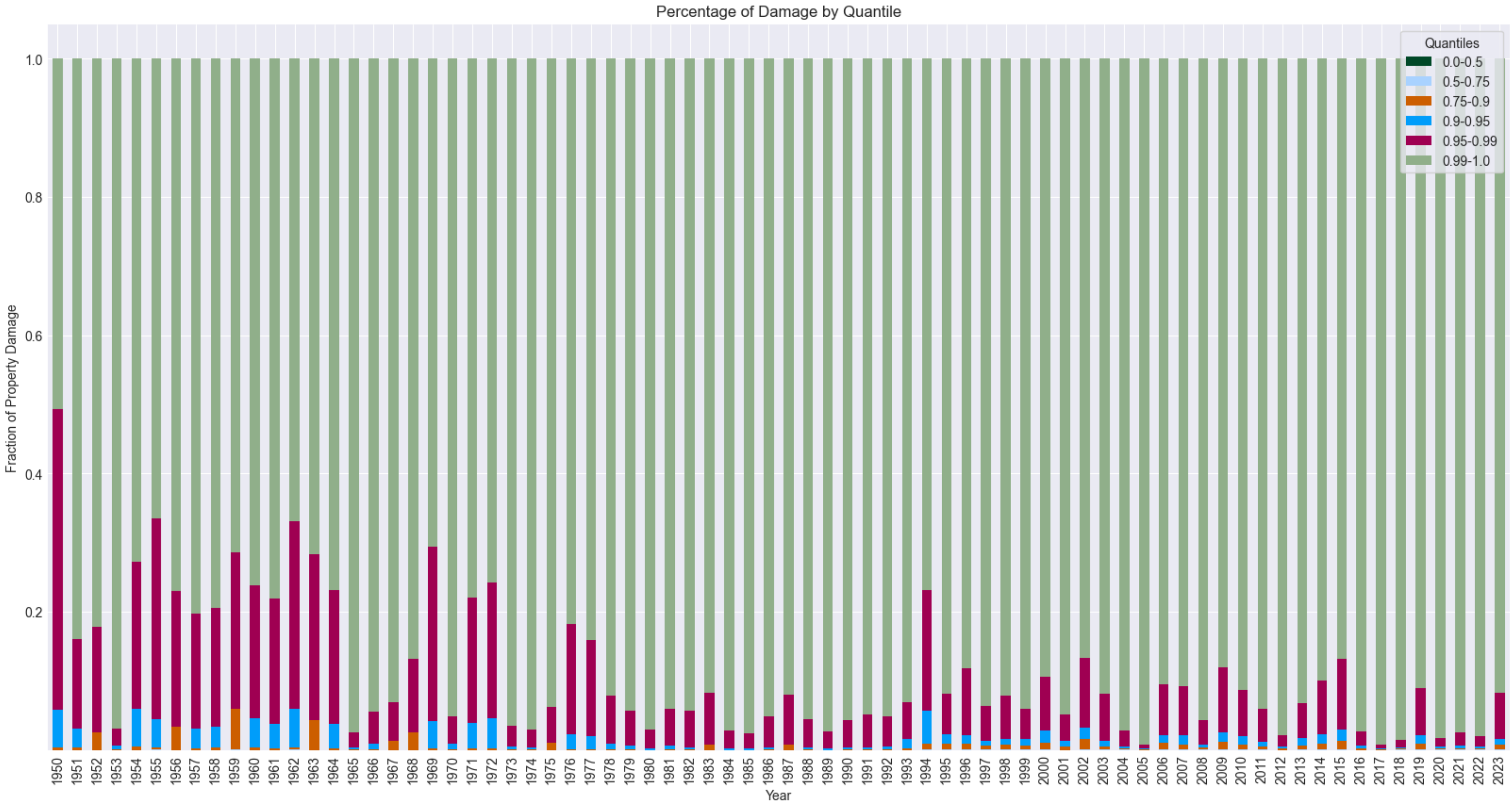
Tools Used

- Pandas
  - Created a Pandas Dataframe in Python from the CSV Storm Event Data Files
  - Allowed for efficient data cleaning and preliminary analysis
- NumPy
  - Python tool to help clean, pre-process, and simplify the data set
- StatsModels
  - Statistical modeling and regression calculations for correlation analysis to answer the proposed questions
- Seaborn and Plotly
  - Tool to create graphs and data visualizations

Data Mining Analysis Applied

- Regression Models
  - Determine relevant correlations between data attributes to predict future storm event damage cost and injury counts
- Outlier Analysis
  - Normal EDA tools such as histogram and box plots were not effective due to dominance of outliers in dataset


Damage by Event Type with Largest Outlier Types Removed
Box Plot with Outliers
EVENT_TYPE_CONSOLIDATED
Tornado
Hail
Thunderstorm
Winter Storm
Storm Surge/Tide
Flood
High Wind
Wildfire
Avalanche
Other
Lightning
Drought
Cold
Marine Events
Heat
Tropical Storm/Depression
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
1e10
DAMAGE_PROPERTY_NUMERIC
Box Plot with Outliers Removed
EVENT_TYPE_CONSOLIDATED
Tornado
Hail
Thunderstorm
Winter Storm
Storm Surge/Tide
Flood
High Wind
Wildfire
Avalanche
Other
Lightning
Drought
Cold
Marine Events
Heat
Tropical Storm/Depression
0
50000
100000
150000
200000
250000
DAMAGE_PROPERTY_NUMERIC


Percentage of Damage by Quantile
Fraction of Property Damage
Year
0.2
0.4
0.6
0.8
1.0
Quantiles
0.0-0.5
0.5-0.75
0.75-0.9
0.9-0.95
0.95-0.99
0.99-1.0
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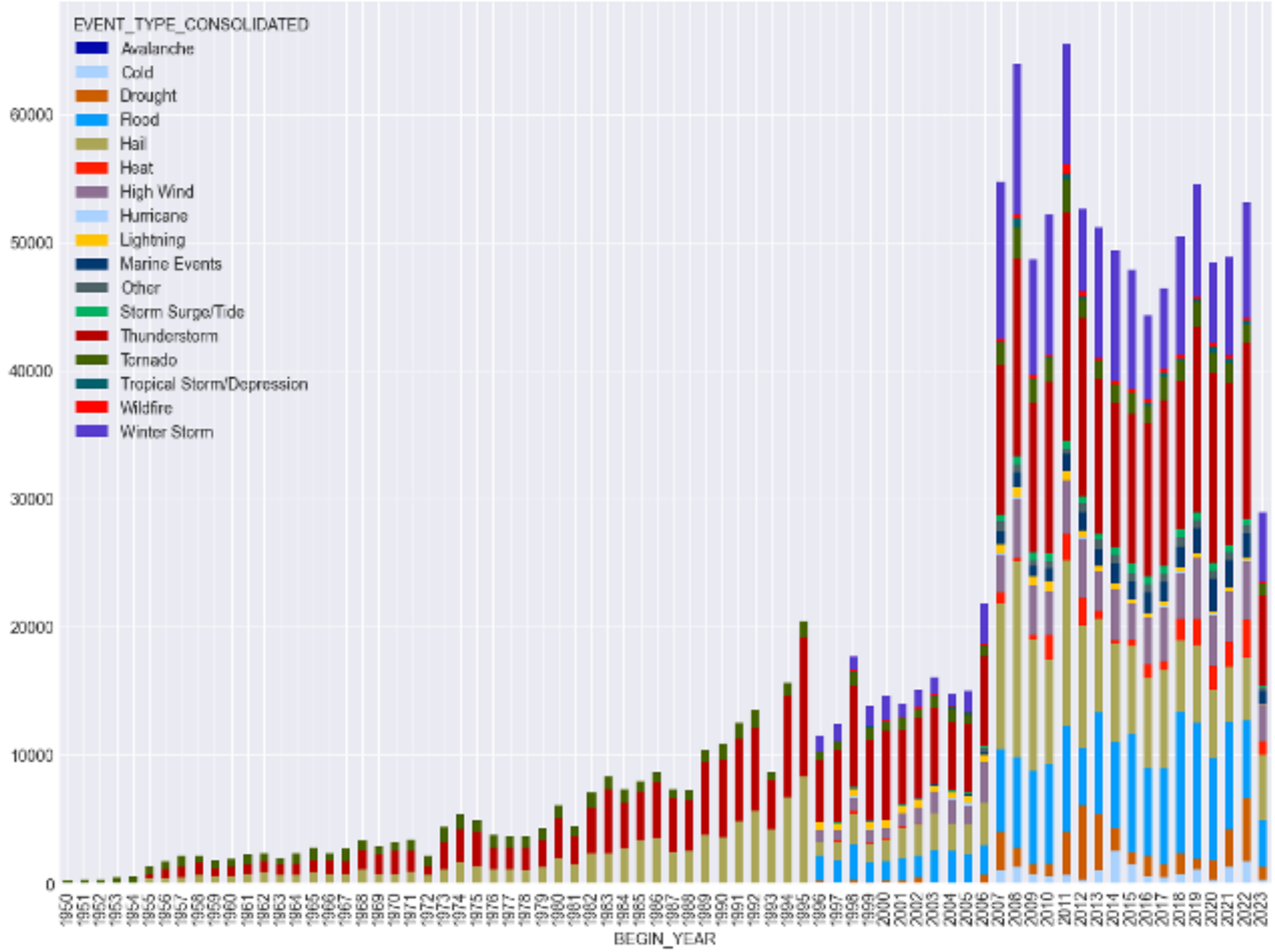
2022
2023

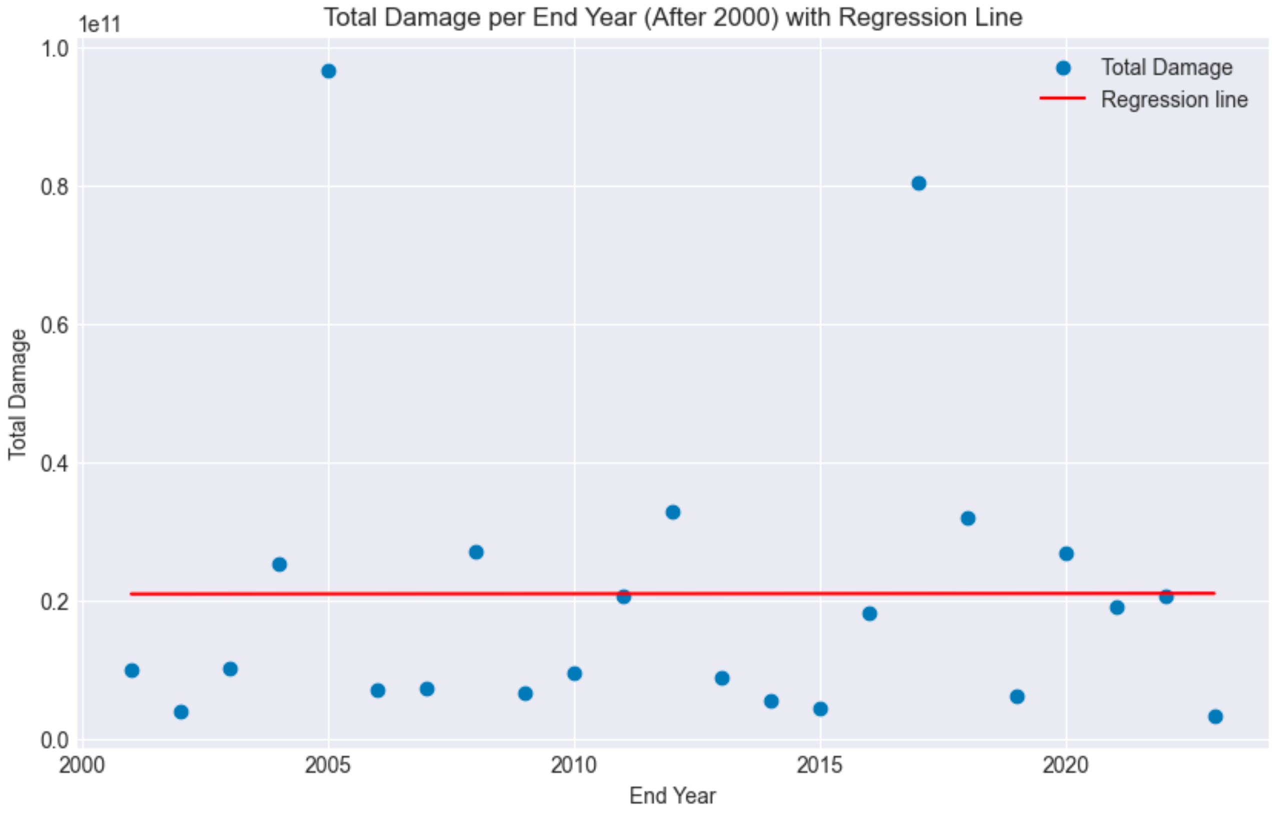
Knowledge Gained – Events per Year

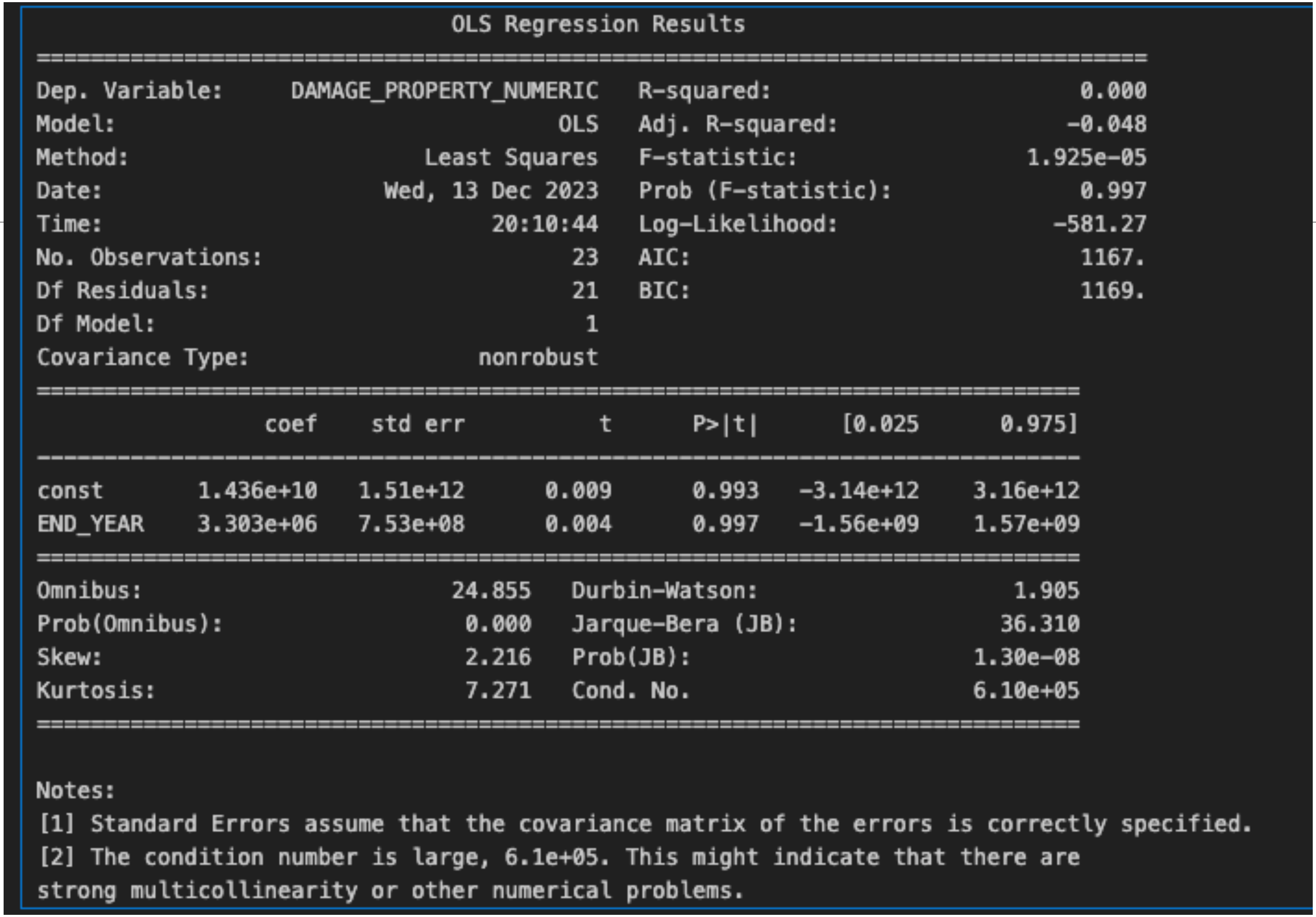
- Has the frequency of storm events increased over time?
- No trend to show an increase in total weather events each year
- Recording of event types has changed significantly in the lifetime of dataset



Knowledge Gained – Damage per Year

- Has the damage caused by storm events increased over time?
- R-squared value = 0.000
- No correlation





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                               OLS Regression Results
===================================================================================
Dep. Variable:     DAMAGE_PROPERTY_NUMERIC   R-squared:                       0.000
Model:                                 OLS   Adj. R-squared:                 -0.048
Method:                      Least Squares   F-statistic:                 1.925e-05
Date:                     Wed, 13 Dec 2023   Prob (F-statistic):              0.997
Time:                             20:10:44   Log-Likelihood:                -581.27
No. Observations:                       23   AIC:                             1167.
Df Residuals:                           21   BIC:                             1169.
Df Model:                                1
Covariance Type:                 nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const       1.436e+10   1.51e+12      0.009      0.993   -3.14e+12    3.16e+12
END_YEAR    3.303e+06   7.53e+08      0.004      0.997   -1.56e+09    1.57e+09
==============================================================================
Omnibus:                       24.855   Durbin-Watson:                   1.905
Prob(Omnibus):                  0.000   Jarque-Bera (JB):               36.310
Skew:                           2.216   Prob(JB):                     1.30e-08
Kurtosis:                       7.271   Cond. No.                     6.10e+05
==============================================================================


Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The condition number is large, 6.1e+05. This might indicate that there are
strong multicollinearity or other numerical problems.
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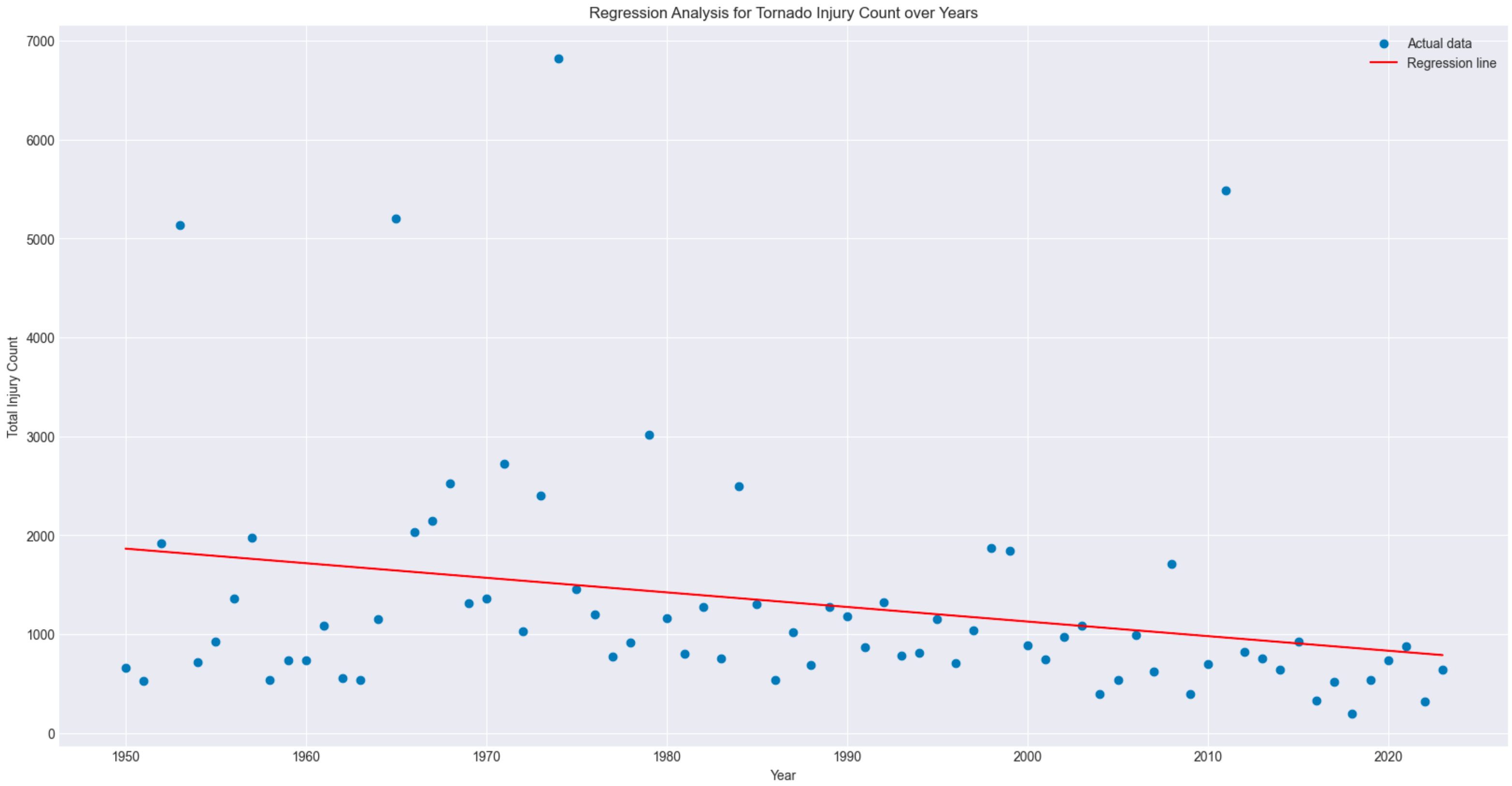
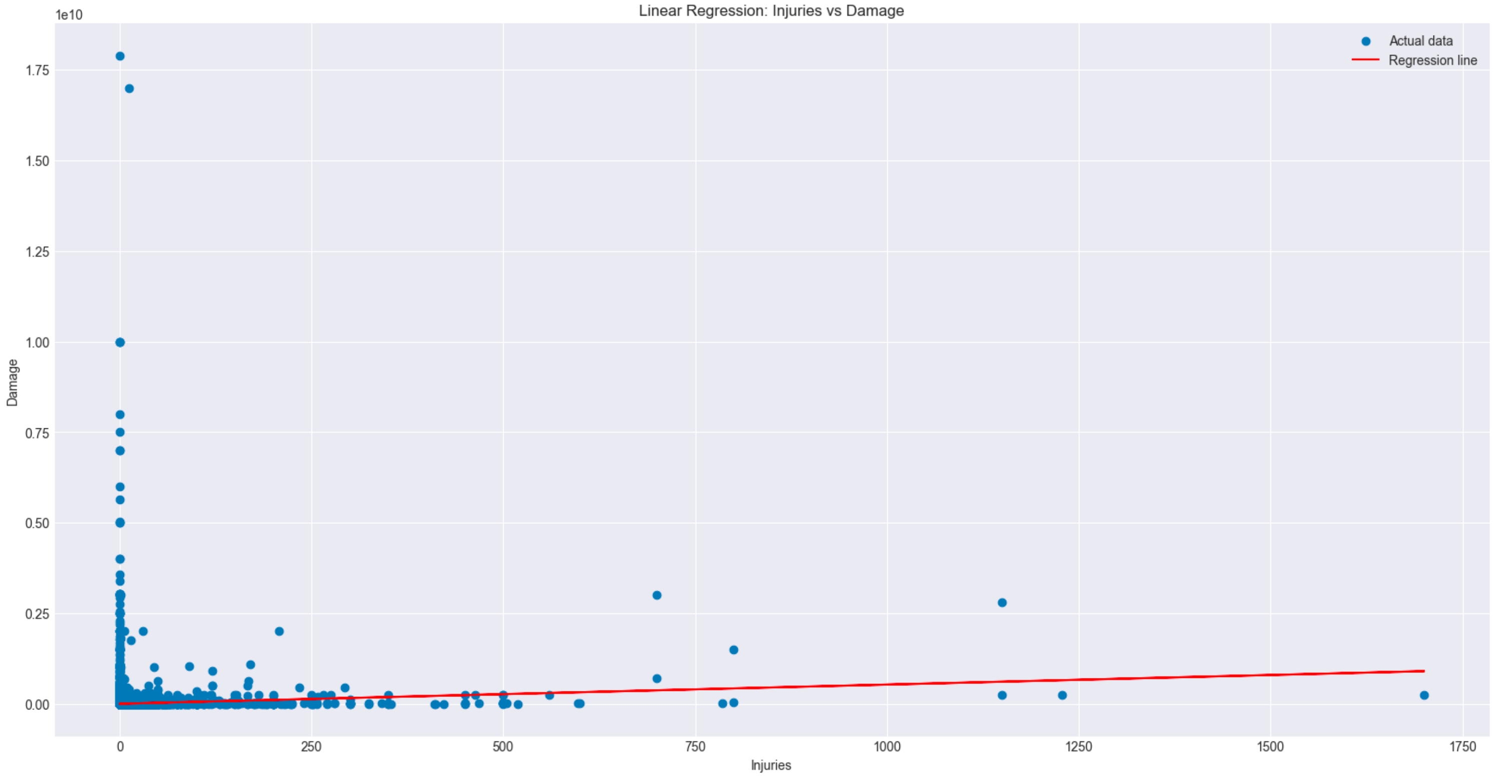
Knowledge Gained – Injury Count

- Have weather events become more dangerous to people?
- R-squared = 0.068
- Outliers skew regression model

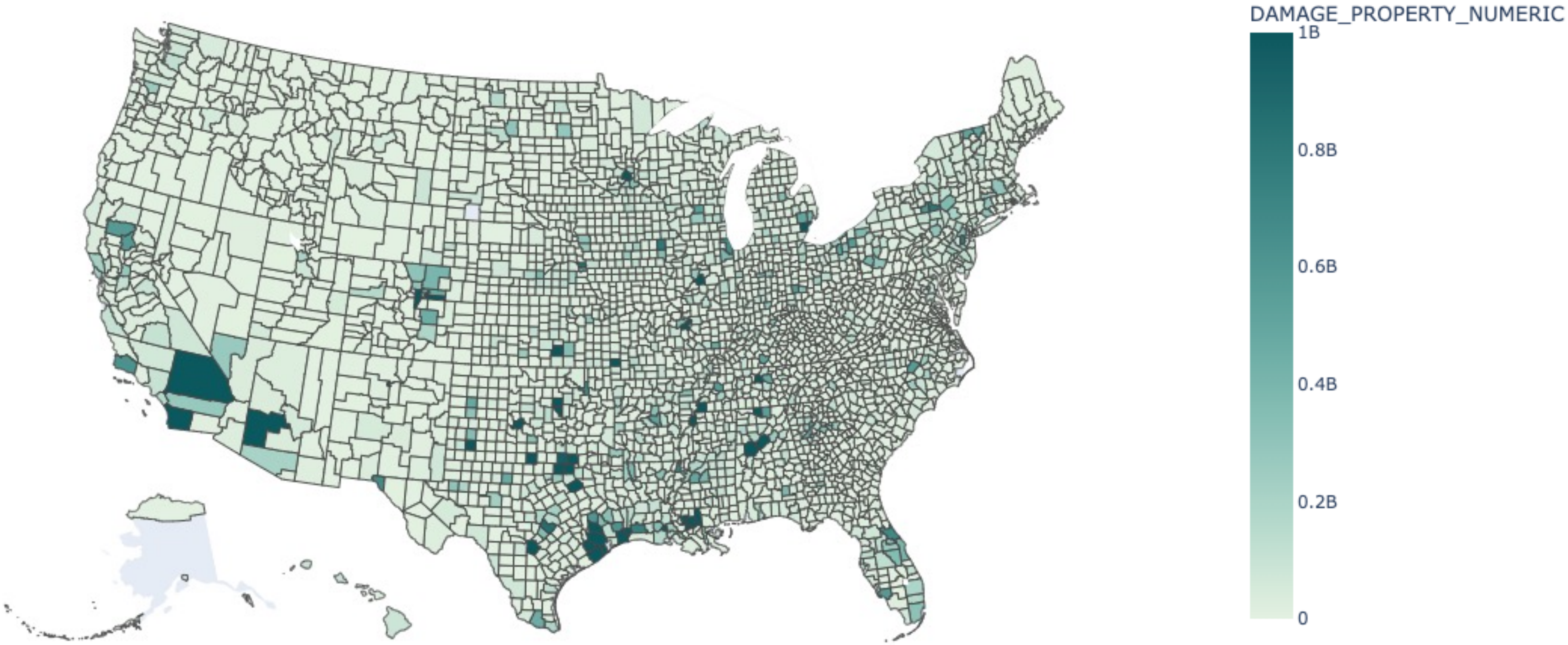


Knowledge Gained – Injuries vs Damage

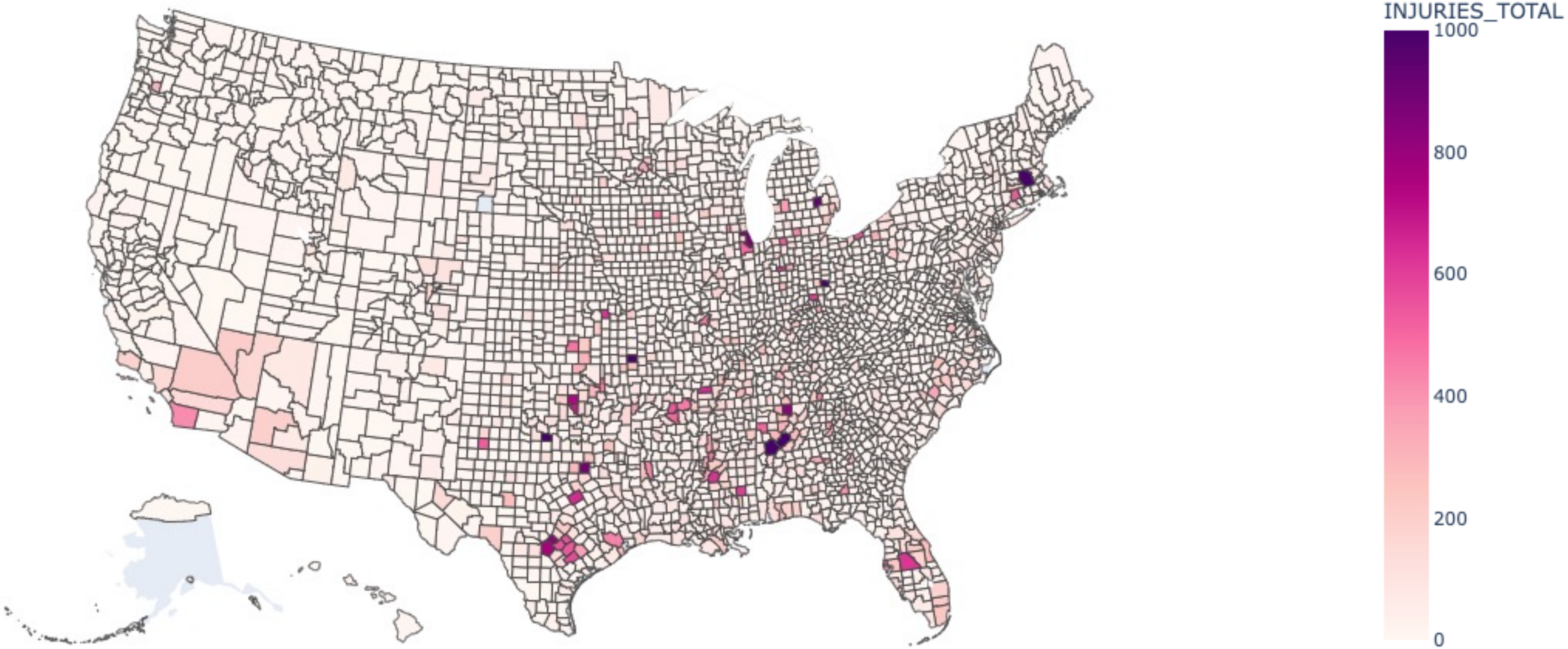
- Is the magnitude property damage indicative of higher risk of injury to people?
- R-squared value = 0.004, no significant correlation



Total Property Damage by County



Total Injuries by County



Knowledge Application

- Better understanding of the risk of severe weather events and allow for better prediction of the outcomes of severe weather events.
    - Future weather events, even if more severe, can cause less damage to people and property, potentially saving lives and preventing huge expenditures.
- Occurrence and location of weather events can give insight into possible other causation factors

Acknowledgements

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P dos Santos, Renato, Some Comments on the Reliability of NOAA's Storm Events Database (June 22, 2016). Available at SSRN: https://ssrn.com/abstract=2799273 or http://dx.doi.org/10.2139/ssrn.2799273